Department of Environmental Protection

Bureau of Land & Water Quality Mar. 1999

Mercury in Wastewater

Mercury is a naturally occurring metal that is commonly found in the environment in small amounts. It is released and dispersed throughout the globe by natural processes and human activities. Several forms of mercury can cause serious health problems in humans and wildlife. Methylmercury, an organic form of the metal, is of particular concern because it is readily taken up by living organisms. There it can persist for long periods of time and become more concentrated as it moves up the food chain.

Fish monitoring programs in Maine and other states have identified many water bodies where concentrations of methylmercury in fish are above levels that are considered safe for human consumption. Mercury-based advisories have been established in 40 states. Advisories in Maine apply to all fresh surface waters of the state. These advisories warn pregnant women, women who plan to become pregnant, and young children to avoid consuming any warm water fish species and to limit consumption of cold water species. The general public is warned to restrict consumption of warm water fish, but faces no restriction on consumption of cold water fish. The fish consumption advisories are aimed at minimizing potential human health risks from mercury, but do not remove the threat mercury poses to wildlife.

During the 118th legislative session when the mercury issue was being discussed, 38 MRSA §420(1) was revisited. This legislation, which was enacted in 1971, prohibited the discharge of mercury or any compounds containing mercury, whether organic or inorganic, in any concentration which increases the natural concentration of mercury in the receiving waters. Because of proposed new testing methods, which now enable mercury to be detected at much lower levels in treatment plant wastewater effluent than previously, there was concern that there may in fact be many facilities that are discharging mercury in excess of that allowed by Section 420(1). This led the Legislature to enact Public Laws 1997, Chapter 722, which requires the Department of Environmental Protection (DEP) to report back to the Natural Resources Committee on the following aspects of mercury:

- Evaluate the current discharges of mercury into waters of the state;
- Evaluate current and potential methods for testing mercury discharges;
- Report of facilities that are in non-compliance with water quality standards for mercury or with 38 MRSA §420;

- Results of effluent testing using more refined testing protocols;
- Evaluation of the sources of mercury in the discharge of facilities that have detectable quantities of mercury;
- Review of incidental sources of mercury;
- Report on natural concentrations of mercury in receiving waters; and
- The status of the Environmental Protection Agency's approval of effluent testing protocols.

In response to this new legislation, the DEP developed monitoring plans to gather information concerning levels of natural concentrations of mercury in receiving waters and levels of mercury in wastewater treatment plant effluents for public and private facilities. All of the effluent samples were collected and analyzed using "clean" techniques, EPA Method 1669 and EPA Method 1631, respectively. These techniques are designed to eliminate contamination from the sampling and analysis process. All the results of these sampling activities were summarized in a report to the legislature on February 1, 1999 entitled "Mercury in Wastewater".

This entire report can be viewed on the Maine DEP Land & Water page under www.state.me.us/dep/docmonitoring/mercury99.doc. If you have any questions, please feel free to contact Sterling Pierce at 287-4868.

Sterling Pierce

Ammonia and Phosphoric Acid Addition

Ammonia and phosphoric acid addition is often incorporated in industrial wastewater treatment systems in order to provide a source of nitrogen and phosphorus for the microorganisms in the activated sludge process. These nutrients are required by the microorganisms to reproduce new cells. Municipal wastewaters usually have sufficient quantities of nitrogen and phosphorus. It is important to properly control the amount of ammonia and phosphoric acid to satisfy the biological requirements. However, it is also important not to overfeed because it wastes chemicals, may promote algae growth in the clarifiers or surplus ammonia may interfere with chlorination. The amount of ammonia and phosphoric acid that must be added is based of the amount of BOD removed by the system. Five pounds of nitrogen, as N, and one pound of phosphorus, as P, are required for every one hundred pounds of BOD removed.

The following is an example calculation to determine the ammonia feed rate:

Step No. 1

Determine the pounds of pure ammonia required by using the following formula:

$$Nreq = Q \times 8.34 \times ((BODr/Rn) - Cn)) \times Ma/Mn$$

where:

Nreq = Nitrogen required, lbs/day of ammonia
Q = Forward flow to the process, mgd
BODr = BOD removed, mg/l

Rn = 100:5 = 20

Cn = Nitrogen in influent wastewater, mg/l

Ma = Molecular weight of ammonia (17)

Mn = Molecular weight of nitrogen (14)

8.34 = Conversion factor

Step No. 2

Determine the pounds of aqueous ammonia required by using the formula shown:

AAreq, lbs/day = Nreq, lbs/day (from Step No. 1)/0.3*

- Since aqueous ammonia is usually 30% nitrogen, 0.3 is used to convert from nitrogen requirement to aqueous ammonia requirement.

Step No. 3

Convert the aqueous ammonia requirement (Aareq) to gallons per day using the formula below:

AAreq, gpd = AAreq, lbs/day (from Step No. 2)/(0.89 x 8.34 lbs/gal)

Where:

0.89 = Specific gravity of 30% aqueous ammonia

Sample Calculation

Assume:

Q = 10 mgd
Cn = 2 mg/l
BODinf = 250
BODeff = 20

Therefore:

BODr = BODinf – BODeff = 250 – 20 = 230 mg/l

Nreq = 10 mgd x 8.34 x ((230/20) – 2)) x (17/14) = 962 lbs/day

AAreq = 962/0.3 = 3,200 lbs/day

AAreq = 3,200/(0.89 x 8.34) = 432 gpd

The 100:5:1 ratios should be used for establishing feed rates that are average values over a wide range of conditions. These ratios can be used as a starting point. To determine if sufficient quantities have been added, the plant effluent should be analyzed for residual levels of total soluble inorganic nitrogen (ammonia-N and nitrate-N) and soluble orthophosphate. These analyses should be performed on filtered samples. Typical guidelines for nitrogen and phosphorus in the effluent are 1 – 2 mg/l and 0.1 – 0.2 mg/l, respectively.

The following factors are also important when dealing with nutrient addition:

- The BOD:N:P ratio of 100:5:1 is based on theoretical needs. Some industries such as paper mills use a ratio of 100:2.5:0.4 with success.
- At high MCRT nutrients are recycled in the activated

sludge process so that less nutrients are required.

- The nutrient requirements increase at lower temperature.
- Both ammonia and nitrate nitrogen should be monitored in the final effluent because high nitrate concentration can result in denitrification and sludge flotation in the final clarifiers.
- Commercial fertilizers with nitrate should not be used because nitrate buildup leads to denitrification.
- Papermill effluents often interfere with colorimetric tests. An ion-specific probe is recommended.

Don Albert

Certification News

Of the 338 operators whose certificates were due of March 1, 1999, we have received renewal forms from 206 operators. If you have an ***ODD*** certificate number, you should have contacted us by now. If your certification was due on March 1, 1999, and you have not renewed your certificate, please contact us as soon as possible. We can help you make sure that your certificate is renewed. If we don't hear from you by the first of April, you will receive a notification that your certificate is no longer valid. You can reinstate your certificate before September 1, 1999 by showing proof of adequate training and paying a $30.00 reinstatement fee. After September 1, 1999, you may be required to retake your certification examination to have your certificate reinstated. We would review your employment records and have the discretion to reinstate your certification if you show that you "have performed your duties satisfactorily and in a manner that demonstrates that an examination is not necessary." If you allowed your certification to remain inactive after March 1, 2001, we have no choice but to permanently revoke your certificate and you would have to pass the exam again to get your certificate back.

For Practice

1. Why should you avoid getting coagulation chemicals on your skin or in your eyes?
   a. Coagulation chemicals can cause nausea and vomiting.
   b. Coagulation chemicals can cause dizziness and sleepiness.
   c. Coagulation chemicals can cause irritation and possible permanent damage.
   d. Coagulation chemicals can cause sneezing and headaches.

2. One summer morning, you look into your secondary clarifiers and see that the sludge is rising in clumps that float on the surface and are discharged over the effluent weirs. The most likely cause of this condition is..
   a. Denitrification causing a rising sludge blanket.
   b. Excess dissolved oxygen being carries into the clarifiers and forming bubbles that float the sludge.
   c. Young sludge which isn't settling properly.
   d. Straggler floc caused by old sludge which doesn't form a good blanket.

3. The term “return sludge” refers to sludge from the
    a. Primary Clarifiers going to sludge treatment
    b. Secondary clarifiers going to the aeration basins
    c. Anaerobic digesters going to the dewatering equipment
    d. Aerobic digester going to the dewatering equipment.

4. A stabilization pond needs to have 150 days of storage to avoid discharging during periods of low flow in the receiving stream. The pond is 17.2 acres (750,000 square feet) in area and receives an average of 150,000 gallons of wastewater per day. There is no loss of water from the pond due to evaporation or percolation. How much freeboard (unused depth) must be available at the start of the non-discharge period.
    a. 1.6 foot
    b. 2.3 feet
    c. 4.0 feet
    d. 8.7 feet

Spring Exam

The Spring wastewater operator certification exam will be given in Portland, Bangor and Presque Isle on May 12, 1999. Applications must be received by us by ***March 31, 1999***.

UPCOMING TRAINING COURSES

March 16, 1999 in Augusta, ME, Macerating Equipment and Grinder Pump Maintenance - approved for 6.0 hours, sponsored by JETCC (207) 767-2539.
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March 17, 1999 in Orono, ME, Sewer Use Ordinance Review - approved for 5 hours, sponsored by MRWA (207) 729-6569.
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March 17, 1999 in Old Orchard Beach, ME, Ultrasonic Flow Measurement - approved for 4 hours, sponsored by MRWA (207) 729-6569.
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March 18, 1999 in Augusta, ME, Ultrasonic Flow Measurement - approved for 4 hours, sponsored by MRWA (207) 729-6569.
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March 19, 1999 in Bangor, ME, Ultrasonic Flow Measurement - approved for 4 hours, sponsored by MRWA (207) 729-6569.
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March 23, 1999 in Presque Isle, ME, Control Valves, Water Hammer, and VFD’s - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.
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March 24, 1999 in Auburn, ME, Control Valves, Water Hammer, and VFD’s - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.
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March 25, 1999 in Old Orchard Beach, ME, Control Valves, Water Hammer, and VFD’s - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.
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April 5, 1999 in Auburn, ME, Wastewater Operator Certification Course for Exam Level I & II - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.
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April 7, 1999 in Skowhegan, ME, Process Control and Solids Handling - approved for 5 hours, sponsored by MRWA (207) 729-6569.
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April 7, 8 & 9, 1999 in Rockland, ME, Operation & Maintenance of Wastewater Collection Systems - approved for 13 hours, sponsored by MRWA (207) 729-6569.

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April 13, 1999 in Ellsworth, ME, Caring for your Lab Instruments and Interpreting you Laboratory Reports - approved for 6.0 hours, sponsored by JETCC (207) 767-2539.

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April 14, 1999 in Bangor, ME, Wastewater Operator Certification Course for Exam Level I & II - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.

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April 16, 1999 in Presque Isle, ME, Wastewater Operator Certification Course for Exam Level I & II - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.

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April 27 1999 in Presque Isle, ME, Wastewater Operator Certification Course for Exam Level III & IV - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.

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April 27, 1999 in Kittery, ME, Basic Process Control Tests for Activated Sludge Systems - approved for 6.0 hours, sponsored by JETCC (207) 767-2539.

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April 29 1999 in Presque Isle, ME, "One Plan"/Integrated Contingency Planning - approved for 3.5 hours, sponsored by MRWA (207) 729-6569.

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April 30 1999 in Augusta, ME, "One Plan"/Integrated Contingency Planning - approved for 3.5 hours, sponsored by MRWA (207) 729-6569.

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May 5 1999 in Auburn, ME, Wastewater Operator Certification Course for Exam Level III & IV - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.

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May 6, 1999 in Bangor, ME, Wastewater Operator Certification Course for Exam Level III & IV - approved for 5.5 hours, sponsored by MRWA (207) 729-6569.

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May 20, 1999 in Bangor, ME, Troubleshooting WWTP Operations - approved for 6.0 hours, sponsored by JETCC (207) 767-2539.

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April 15, 1999 in Augusta, ME, 1999 Maine Water Conference - approved for 6.0 hours, sponsored by the University of Maine Water Research Institute (207) 581-3244.

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Answers to *For Practice:*

1. c. Coagulation chemicals contain astringents which can cause irritation to the skin and possible permanent damage to the eyes.
2. a. The most likely cause of sludge rising in large clumps in the secondary clarifier is denitrification. As the nitrates are used by faccultative bacteria, nitrogen gas is released and forms bubbles which can carry large clumps of sludge to the clarifier surface. Young sludge may have poorly settling floc particles and old sludge may have straggler floc, either of which can result in small particles of sludge overflowing the effluent weir but not large clumps of sludge. Excess dissolved oxygen carries into the secondary clarifiers is used by the aerobic bacteria to continue to break down the organic matter in the wastewater and would not come out of solution and cause rising sludge.

3. b. Return Sludge is the sludge returned to the aeration basins from the secondary clarifiers.

4. c. In 150 days, the pond will receive 22.5 million gallons or 3 million cubic feet of water. If the surface area is 750,000 feet, the depth of the freeboard must be 3,000,000/750,000 = 4.0 feet.